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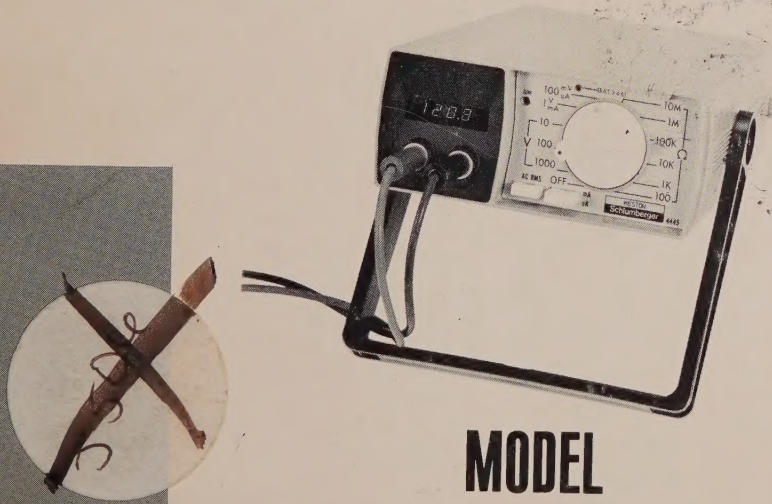
WESTON®

DIGITAL MULTIMETER



MODEL 4445

INSTRUCTIONS/PARTS LIST

STOP

IN CASE YOU ARE IN A HURRY TO USE YOUR NEW WESTON DIGITAL MULTIMETER (DMM).

1. Connect the DMM to the power line for a 16 hour interval with the DMM turned off before attempting to operate from the self-contained NiCad batteries. See Section 4.
2. To make AC measurements, the AC push button should be pushed and latched in the depressed position. To return to DC measurements, depress the button and release.
3. To make 100μA or 1mA current measurements, the mA/μA push button should be pushed and latched in the depressed position. To return to voltage and resistance measurements, depress the button and release. However, when external shunts are used to measure current, the DMM should be in the 100.0mV range.
4. When ohms measurement are made, DC current flows out of the + terminal through Rx and back to the - terminal. The test current is limited to a maximum of 1mA, but the voltage appearing on the test leads can approach 12 volts on an open circuit. Normal, in-range measurements, are made with a maximum of 2 volts across Rx. On the 100.0Ω range, test lead and jack resistances of a few tenths of an ohm will be displayed.
5. A blinking one in the thousands place with all other digits extinguished indicates a reading of 2000 counts or greater. It can also occur with battery voltages less than 4.6 volts.
6. On line operation, do not float the meter more than 500V RMS above power ground.
7. It is normal for the display to drift off to overrange with the input open circuited on the 1V and 100mV ranges.
8. A blown input fuse will cause an overrange condition to be displayed, even with the input leads shorted, on all ranges and functions except 10, 100 and 1000 volts (which will read 000). Refer to section 4 for location of spare fuse and method of replacement.
9. In the Model 4445, 62 or more volts applied at the input terminals when the mA/μA push button is depressed will cause the input fuse to blow.
10. Be certain the spring is in the input fuse holder when a new fuse is inserted.
11. Check for zero display indication using the 100mV DC range with the inputs shorted. Zero offsets can be corrected using the zero adjustment on the range plate. AC zero-adjust R148 (rear panel) at 1 VAC for reading of 0.0, approaching from direction of positive readings and not going beyond zero.

ERRATA SHEET
MODEL 4445
TRUE RMS DIGITAL MULTIMETER

Instruction Manual F-3792-999

Pages 7-2 and 7-9	Under U102 RMS TO DC CONVERTER MODULE - Part Number 274669-001 has been changed to "Part Number 276471-901".

WESTON INSTRUMENTS,INC.
614 FRELINGHUYSEN AVENUE, NEWARK, N. J. 07114

WESTON
Schlumberger

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SECTION 1

GENERAL INFORMATION

DESCRIPTION

The Weston Model 4445 is a 3-1/2 digit solid state portable Digital Multimeter (DMM) designed for either field use or laboratory applications. The Model 4445 DMM is light-weight and shock-proofed. It is self-contained in a high-impact resistant plastic case. The carrying handle serves a dual purpose as a tilt-stand. The unit may be panel mounted using accessory brackets.

Four self-contained rechargeable (and easily replaced) nickel cadmium C size batteries provide a minimum of five (5) hours of continuous operation. A plug-in battery charger, provides for normal line operation both while the batteries are being recharged and to maintain the batteries in a full charged state, The DMM can also be operated using standard zinc carbon or alkaline type C size batteries.

Twenty ranges at 3-1/2 digit resolution cover 100.0 millivolts to 1000 volts AC/DC, 100.0 ohms to 10 megohms, plus 100.0 microamperes and 1.0 milliamperes AC and DC current, with 100% overrange capability on all ranges except the 1000 volt range. Accessory plug-in shunts are available to extend the current ranges.

The basic measuring circuit is a high impedance bipolar analog-to-digital converter using patented dual-slope integration to achieve accuracy and long term stability. The basic DC measurement ranges are 100 millivolts and 1 volt. An attenuator is used on all other ranges. AC voltage is converted to DC by a transconductance type RMS to DC converter module operated at a full scale level of 1.0 volts. All AC voltages are scaled to this level by a buffer amplifier and switched gain preamplifier. Currents are measured by the voltage drop across a shunt. Full scale indications are produced with a maximum voltage drop of 100 millivolts (the internal 1mA range has a 1 volt drop). Resistance is measured by passing a scaled current through the unknown resistance and measuring the DC voltage across it. The maximum current is 1 milliampere. The 1kΩ, 100kΩ, 1MΩ and 10MΩ ranges provide a maximum voltage drop across the unknown of 2 volts (allowing forward biasing of semi-conductor junctions in continuity tests). Other ohm ranges utilize up to 200 millivolts.

The Model 4445 is designed for ease of operation. There are only two front panel jacks, a rotary range-function switch, and two push-buttons to select

DC/AC and/or current operation. No switching is required to select battery, line operation, or battery recharge. Special features include a custom designed plug-in solid state LED readout, a single MOS-LSI plug-in chip for all logic circuit functions, auto-polarity, automatic blanking of unused digits to conserve battery power and improve display readability, overload protection and overrange indication. A test point is accessible through a hole in the dial plate to permit monitoring battery voltage.

SECTION 2

SPECIFICATIONS

Display	Maximum Count: 1999 Overrange Indication: Automatic beyond 1999 blinking 1 in thousands place, polarity indication, and decimal point. Polarity Indication: Automatic, Negative "-" Reading Rate: Approximately 4 per second, non-blink Numeric Display: .19" character size, seven segment LED with integral decimal points
Power Requirement . .	105 to 130VAC (210 to 260 VAC optional) Line Frequency: 50 to 400Hz Power Drain: 6 watts into charger, nominal 1.5 watts at 5.0V into DMM
Accessory . . .	Battery Charger — 105 to 130VAC, Part No. 274893 std. equip. (210 to 260 VAC, Part No. 275805 optional) Test leads — std equip. Part No. 270066-001 Hardware, Panel mtg — optional Catalog No. 0274381 Batteries — std equip. Four C size nickel cadmium Part No. 274120-001 or equivalent Carrying Case — optional Catalog No. 9740-273454
Power Line Isolation . . .	May be operated 500V above power line ground (during line operation).
Operating Temperature . .	0°C to 50°C Battery operation 5°C to 45°C Line operation 5°C to 40°C Charging with DMM off
Storage Temperature . .	-40°C to 50°C (upper temperature limited by batteries, 70°C without batteries)
Normal Mode Rejection . . .	38dV minimum at 50Hz
Common Mode Rejection . . .	80dB (line operation) Extended on battery operation
Size	2.26" H x 5.43" W x 7.01" D (57.40mmH x 137.92mmW x 178.05mmD)
Weight	2-1/2 pounds (1.14kg)

DC VOLTS

Range	*Zin*	*Accuracy 25°C ± 3°C*	*Overload Protection (Resis. & Clamping Diodes)*
100.0mV 1.000V	100MΩ 1000MΩ	±0.05% Rdg ±1 digit	300V 300V
10.00V 100.0V 1000V	10MΩ 10MΩ 10MΩ	±0.1% Rdg ±1 digit	1100V 1100V 1100V

With 100% overrange on all ranges except 1000V range

Step Response: 2 seconds
Input Bias Current: 7nA Maximum
Temperature Influence (%/°C): ±75PPM rdg.

AC VOLTS (RMS Sensing, RMS Calibrated)

Range	*Zin*	*Accuracy 25°C ± 3°C*	*Overload Protection Resis. & Clamping Diodes*
100.0mV 1.000V 10.00V 100.0V	10MΩ 150pF	±.35% FS ±1 digit (50-400Hz) ±.5% FS ±1 digit (40-10000Hz) ±1.5% FS ±1 digit (30-20000Hz)	250V RMS 250V RMS 1000V RMS 1000V RMS
1000V		±.5% ±1 digit (40-2500Hz)	1000V RMS

With 100% overrange on all ranges except 1000V range

In overrange region accuracy is % reading instead of % FS
Step Response: 5 seconds
Temperature Influence: ±300PPM FS/°C

CREST FACTOR 4:1

RESISTANCE

Range	*Measuring Current*	*Accuracy 25°C ±3°C*	*Overload Protection*
100Ω 1kΩ	1mA 1mA	±0.25% Rdg +3 -1 digit ±0.25% Rdg ±1 digit	250V RMS
10kΩ 100kΩ	10μA 10μA	±0.15% Rdg ±1 digit	350V RMS
1MΩ	1μA	±0.2% Rdg ±1 digit	
10MΩ	100nA	±0.5% Rdg ±1 digit	

With 100% overrange on all ranges

Step response: 2 seconds
except (2MΩ 3 seconds) (10MΩ 15 seconds)
Temperature Influence: ±200 PPM Rdg/°C except
1 Megohm range: ±300 PPM/°C, Max.
10 Megohm range: ±300 PPM/°C, Typical

CURRENT

Range	*Accuracy 25°C ±3°C*	*Overload Protection (fuse)*
DC 100.0μA 1.000mA	±0.2% Rdg ±1 digit	1/16 Amp

Temperature Influence: 100 PPM RDG/°C

AC 100.0μA 1.000mA	±.6% FS ±1 digit (40-10000Hz) ±1.5% FS ±1 digit (30-20000Hz)	1/16 Amp

Temperature Influence: 300 PPM FS/°C

SECTION 3
INSTALLATION

GENERAL

Inspect the instrument for possible damage in shipment. If damage is noted, notify the carrier and supplier before using the instrument.

CARRYING HANDLE-TILT STAND

The handle incorporates a detent mechanism to provide an adjustable tilt-stand. The detent portion of the handle is supplied with a positive-lock mechanism.

To change the position of the handle, grasp handle as shown in Figure 3-1, pulling outward with thumb against case, thereby pulling handle free of detent. Do this on both sides. Rotate the handle to the desired position, engage detent and push to lock both sides.

PRECAUTIONS

BEFORE REMOVING THE INSTRUMENT CIRCUIT BOARDS FROM THE CASE, PULL OUT (UNLOCK AS ABOVE) HANDLE FROM THE CASE TO PREVENT DAMAGE TO CIRCUIT COMPONENTS.

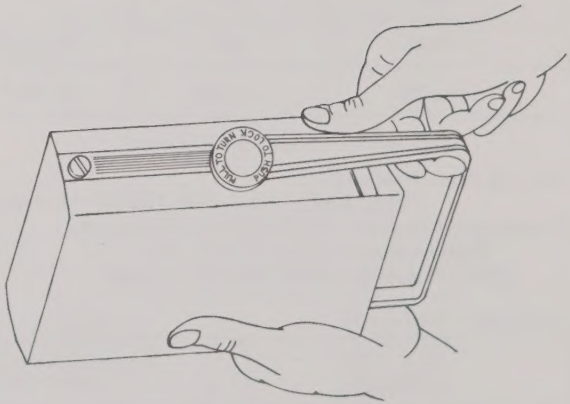

Figure 3-1. Unlocking Positive-Lock Mechanism

PANEL INSTALLATION

The instrument is provided with an option for mounting on a panel. Special mounting hardware is available under Catalog No. 0274381. The dimensional drawing is shown in Figure 3-2 and panel cut-out dimensions are given in Figure 3-3.

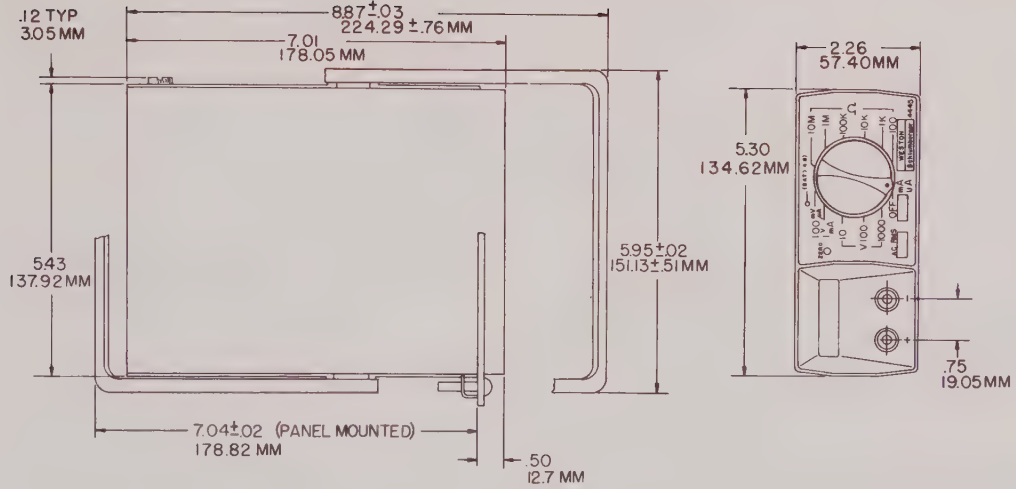

Figure 3-2. Dimensional Drawing

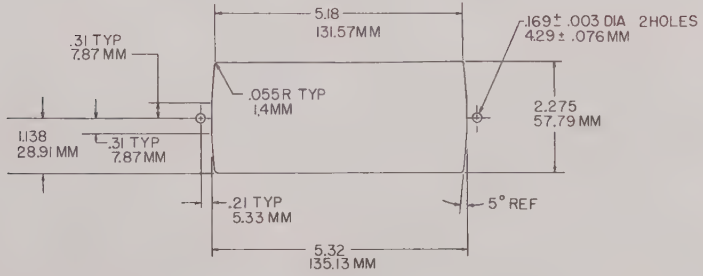

Figure 3-3. Panel Cut-Out Dimensions

SECTION 4
OPERATION

BATTERY OPERATION

The digital multimeter (DMM) will operate on its internal batteries. The state of charge should be checked periodically by following these steps.

NOTE The instrument is shipped from the factory with the batteries discharged. See AC OPERATION AND RECHARGING for charging procedure.

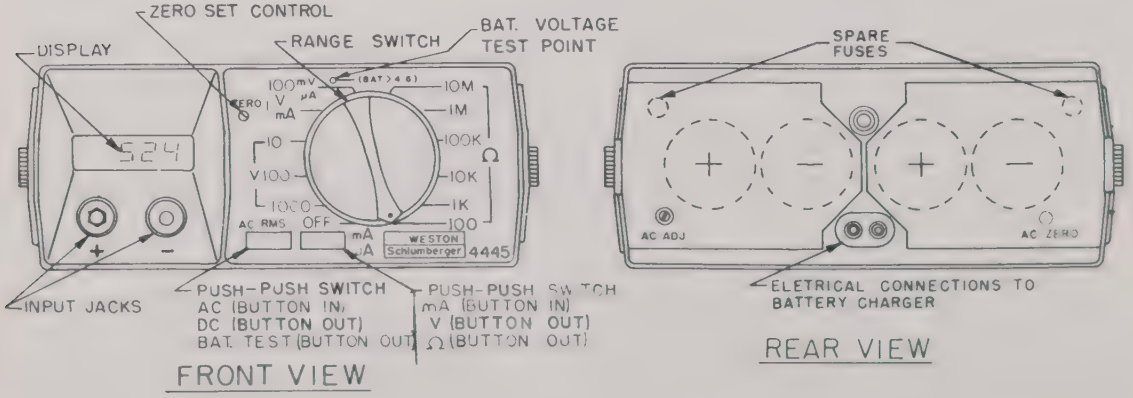

Figure 4-1. Front and Rear Panel Views

1. Set RANGE SWITCH in 10 volt position.
2. Set AC pushbutton switch in DC position (button OUT).
3. Insert test leads into input jacks. Insert probe tip of positive input lead, into battery voltage test point.
4. Display shall be greater than 4.60 volts.

If either the battery voltage is close to 4.6 volts or all digits do not emit light, and the batteries are properly installed, recharging is required. A couple of days of intermittent operation are possible using zinc-carbon or alkaline C size batteries.

AC OPERATION AND RECHARGING

1. Range switch is the power control. Power is supplied to all indexed positions except OFF.

NOTE: Nickel cadmium batteries must be properly installed for AC operation and recharging.

2. Plug battery charger into rear of DMM and power outlet. The instrument can be connected to the power line indefinitely. The plug on the battery compartment is polarized. Caution should be observed to avoid damaging the connectors.
3. If batteries are discharged below 4.6 volts, set range switch to OFF and connect to power line for at least five minutes before operating.
4. Recharge time of batteries is at least 16 hours with range switch set to OFF. Recharge rate is nominally 10% of full rate while instrument is being operated.

FUNCTION AND RANGE SELECTION

The following table shows function and switch positions for operation.

Function	*Range Switch Position*	*AC Push Button Switch Position*	*mA Push Button Switch Position*	*Notes (See page 4-2)*
Battery Test	10.00V	OUT	OUT	3
Ω	Ω, KΩ, MΩ	OUT	OUT	1,4
DCV	100mV or V	OUT	OUT	1,2
ACV	100mV or V	IN	OUT	1,5
DC mA	100μA; 1mA	OUT	IN	1
AC mA	100μA; 1mA	IN	IN	1,5

NOTES:

1. On line operation, do not float the meter more than 500V RMS above power ground.

2. When the input leads are open circuited on either 100mVDC or 1VDC, the display will slowly drift off to an overrange indication due to integrator bias current.

3. Insert (+) probe in (BAT) hole in the dial plate.

4. On the 100.0 Ω range, test lead and contact resistance will produce a zero offset of a few counts. The user can either null this out with the zero control or subtract the offset from all readings.

5. Reversing the charger plug in the power line may be necessary to avoid offset with a shorted input on some AC ranges.

ZERO ADJUSTMENT

1. Set range switch to 100mV.

2. Set AC pushbutton switch in DC position (button OUT).

3. Short input leads.

4. Adjust ZERO set control for .0 to ± .0 indication.

OVERRANGE DISPLAY – GREATER THAN 100% OF RANGE

Blinking 1 in the most significant digit, balance of digits blanked.

INPUT OVERLOAD PROTECTION

The + input jack has a 1/16 amp fuse to protect against overloads in the mA function. This fuse is replaceable from outside the case. See Figure 4-2. The wrench is at the tip of either of the two thumb screws used to retain the battery compartment.

DISPLAY TEST

A test for proper display operation and for proper decoder-driver operation can be performed by the user. The 100mV and 1VDC ranges are utilized in the test. Short the test leads together causing a display reading of .000. Open circuit the test leads and integrator drift will cause the numbers displayed to drift slowly, increasing negative counts. The 00.0mV range permits a faster count change suitable for checking the more significant digits.

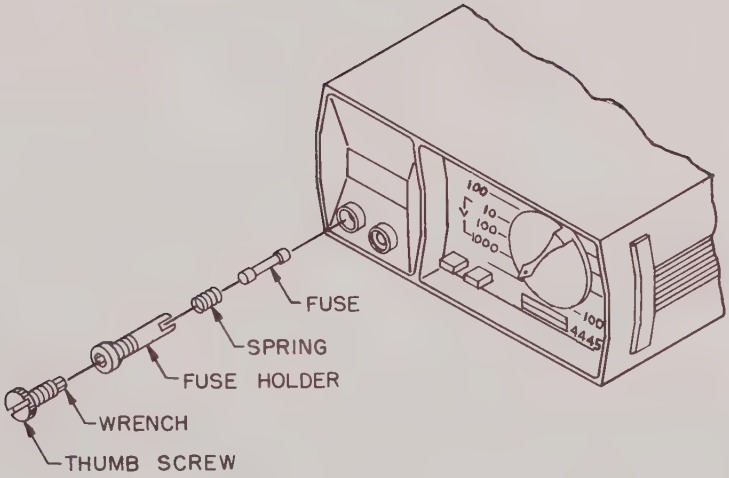

Figure 4-2. Input Fuse Replacement

SECTION 5
THEORY OF OPERATION

INTRODUCTION

This section presents the design and operating principles of the Weston 4445 Digital Multimeter. The theory of operation is presented at the functional level immediately below and in greater detail in the paragraphs following. Complete schematic diagrams and assembly drawings are included for reference in Section 7.

Model 4445 incorporates all circuitry needed to make measurements of DC voltage and current, AC voltage and current, and resistance. The basic measuring circuit is a high impedance bipolar analog to digital converter operating on the dual-slope principle. It has a measurement range of either 100mV or 1 volt DC, depending on the range switch setting. All inputs other than DC volts are converted to DC volts for measurement by this circuit.

Resistance is measured by passing a scaled current through the unknown and measuring the DC voltage across it. Alternating voltages are converted to DC by an RMS sensing, RMS calibrated converter assembly. Full scale output voltage for all ranges is 1.000VDC. Current is measured by the voltage drop across a shunt. If DC, it is measured directly. If AC, DC blocking follows the shunt. Full scale shunt voltage is 100 millivolts.

The DC voltmeter and the several conversion circuits are interconnected by two push button switches and a rotary range switch which make possible decimal point switching, input ranging, gain changes in the A/D converter, and shared usage of the precision attenuator. Interconnection information is presented in the schematic diagrams in Section 7 and the interested user will be better equipped to follow it after first digesting the operating theory of the functional parts that follows.

We have started with the A/D converter, that circuit being basic to all other modes. Then the front-end analog circuitry including attenuator and switching which complete the DC voltmeter circuit. Resistance, current, and AC converter, and power supply follow in that order.

The following paragraphs will present the theory of operation of the DC voltmeter and the several conversion circuits. Figure 5-1 shows the digital multimeter's circuit partitioning.

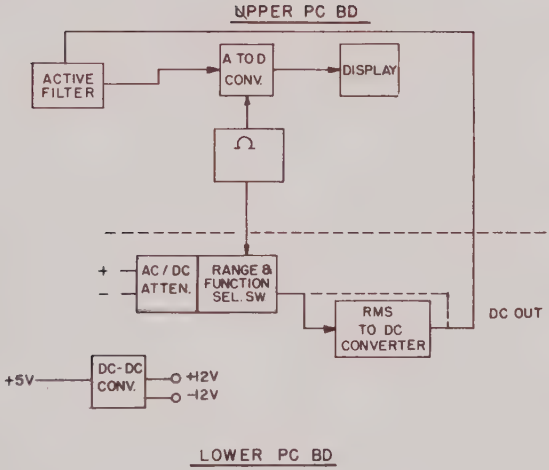

Figure 5-1. Circuit Partitioning

DETAILED CIRCUIT DESCRIPTION

DC VOLTMETER CIRCUIT

The A/D converter is common to all measuring functions. The input voltage may be either 100mVDC or 1 volt DC depending on range setting. All the voltages are scaled to one of these ranges by suitable attenuators, shunts, or converters. The display has a maximum reading of 1999 accompanied by decimal points, polarity sign and an overrange indication.

The circuit operation will be explained with the aid of Waveforms Figure 5-2 and the Block Diagram Figure 5-3.

DUAL SLOPE A/D CONVERSION

Dual slope is an integrating method of A/D conversion which has the following inherent advantages:

1. By proper choice of oscillator frequency, the effect of power frequency interference is reduced.

2. Internal conversion clock frequency accuracy is unimportant since amplitude is converted into a ratio of two time intervals.
3. Comparator threshold accuracy is unimportant.

The technique employed in the Model 4445 has the added advantage of not switching the input signal, eliminating a source of noise which can disturb the quantity being measured.

Figure 5-2 shows the waveforms associated with one conversion cycle. The equation relating E_{in} to a time ratio is as follows:

$$\frac{E_{in}T_1}{RC} = \left[I_{REF} - E_{in/R}\right]\frac{T_2}{C}$$

since $T_1 + T_2 = T$

$$T_2 = E_{in}\frac{T}{I_{REF}R}$$

$$E_{in} = \frac{T_2}{T_1 + T_2} \quad I_{REF}R$$

Figure 5-3 is a block diagram of the A/D converter.

DC VOLTMETER

Basic Logic

The A/D converter logic is incorporated on an MOS-LSI circuit. This includes the portion of the block diagram enclosed in dotted lines. The conversion period is fixed at 10,000 clock pulses. With a count advance from 9999 to 0000, the

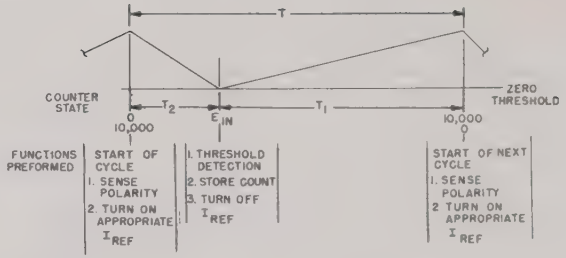

Figure 5-2. Waveforms

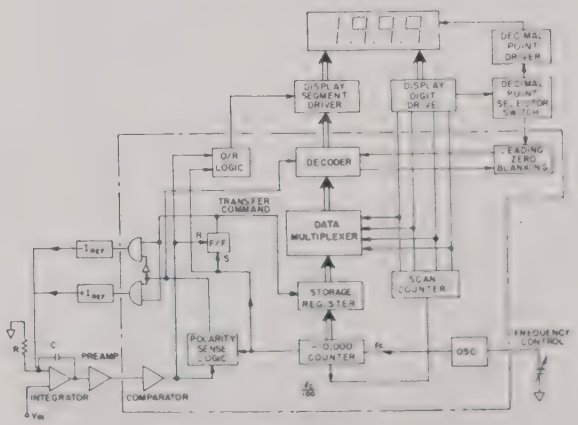

Figure 5-3. Block Diagram

polarity of the integrator output is sensed and stored. Additionally, one of two current references is turned on based on the polarity data. When a comparator threshold is reached, the current reference is turned off, and prior to a new counter advance, the counter states are stored in a register. Meanwhile the counter continues counting.

Strobed Display Operation

The display digits are sequentially energized with each digit updated approximately 100 times per second. The digit-select logic output and the seven (7) segment logic outputs are synchronously supplied by the LSI circuit. See Figure 5-4. Segments are energized on a 10% duty cycle basis to enhance the LED display efficiency.

The Non-Inverting Integrator

The basic integrator circuit, Figure 5-5, consists of an operational amplifier connected in the non-inverting mode for high-input impedance, and the logic-controlled current source necessary for controlling ramp action, as described in the previous paragraph. If, for example, an input voltage of +100mV is applied, the feedback amplifier causes point A to rise to 100mV producing a current through resistor R. In the absence of a reference current, this constant current charges capacitor C and point B will rise linearly to support this charge rate.

When, at the count of 10,000, a reference current is switched into point A, the reference source will supply the current through R and the remaining current will discharge capacitor C. Point B will then

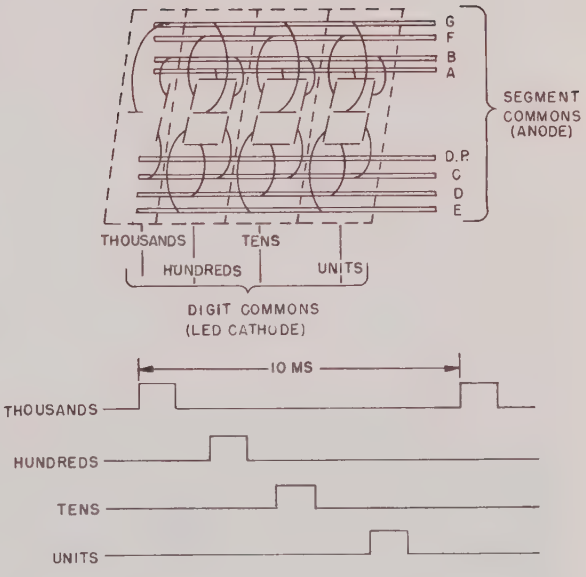

Figure 5-4. Display Strobing

fall back towards zero taking 1,000 clock bits to do this, giving a display of 100.0. Since one complete period is 10,000 counts, the rise will consume 9,000 and the fall 1,000. Other input voltages will give rise to corresponding fall times and displays.

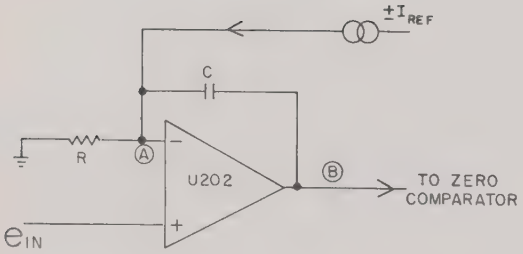

Figure 5-5. Integrator Circuit

Offset Adjustment

Offset voltages in U202, if not compensated, would produce a continuous ramp at B, even with zero input, and the display would stabilize at some small, non-zero reading. To compensate for offset voltage, the ground end of the integrating resistor is returned to an adjustable voltage, low-impedance, source as shown in figure 5-6.

Resistor R231 and its associated resistors provide a 50 ohm source, adjustable to ±8mV to accommodate an 8mV possible offset voltage in the amplifier. The offset adjustment need not be changed when changing ranges.

Input Attenuation

On the two lowest ranges, E_{in} is applied without attenuation. See Figure 5-7. Impedance is provided to assure the integrator a fixed sink impedance, and to absorb overloads. A common attenuator is used for both AC and DC measurements on other voltage ranges. See Figure 5-8.

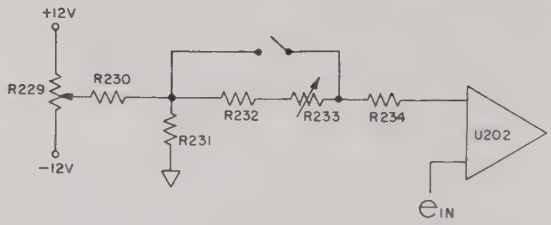

Figure 5-6. Offset Adjustment

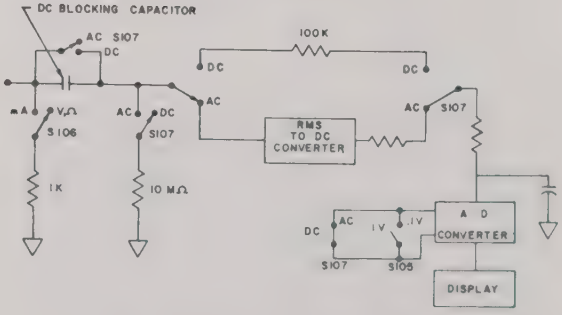

Figure 5-7. 100mV, 1V and Current Ranges

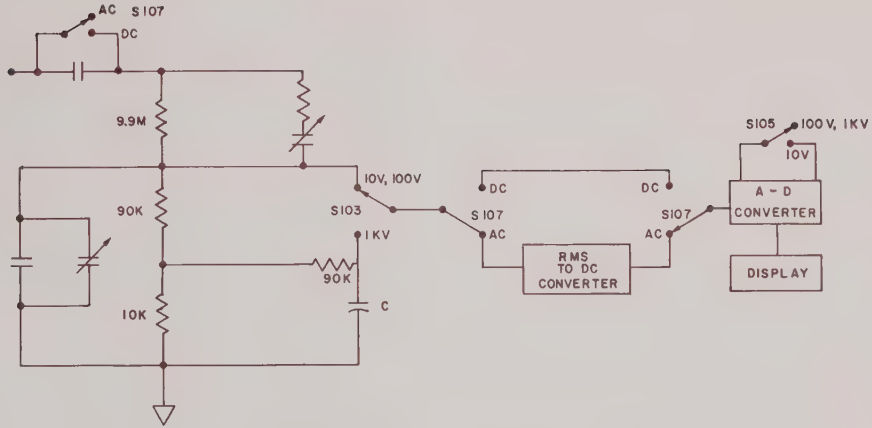

Figure 5-8. 10V, 100V and 1kV Ranges

Reference Current Circuits

The reference current generators consist of a common-base transistor constant current source, and is illustrated in Figure 5-9 for the case of the positive reference.

AC Converter

The measurement of alternating voltages is accomplished by an RMS sensing AC to DC converter module operating at a level of 1.0 volts RMS full scale. It is supported by an input overload protection diode clamp, an operational amplifier gain stage, and post-module filtering to suppress residual ripple.

These circuit elements are shown in simplified form in Figure 5-10. Tracing signal flow from input terminal through to the A/D converter, the following circuit functions are encountered:

1. At the input is a clamp network formed by two low leakage, low capacitance diodes. The input resistor and the diodes protect the FET buffer stage in case of inadvertent application of destructive voltages.
2. A FET/bipolar follower circuit provides high input impedance and low output impedance at approximately unity gain.
3. Following the buffer circuit is the input network of the operational amplifier. Voltages of 100mV or 1 volt, either direct input or

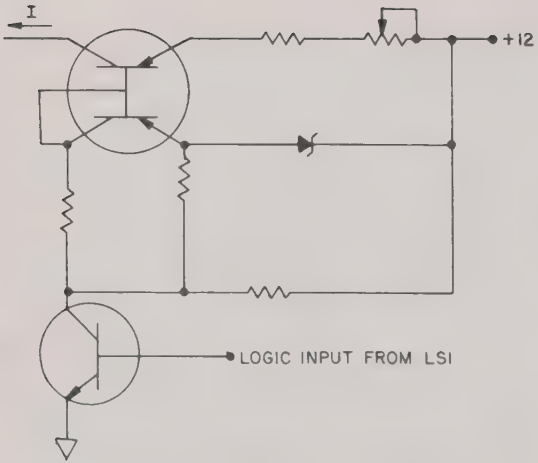

Figure 5-9. Reference Current Circuit

derived from the attenuator are converted into input currents of 10 microamperes RMS. The input network switches in value from 10k to 100k respectively to maintain full scale input current at the 10 microampere level. The remainder of the operational amplifier is designed to create a gain of 1 or 10. The variable resistor in Figure 5-10 provides fine adjustment of this gain.

Ohms Measurement Circuit

A voltage across Rx (Ref. Figure 5-11) is produced by the divider network formed by the 12V supply voltage, Rx, R235 and R226-R228, depending on range selected. The resultant voltage is applied to a modified version of the basic analog-to-digital (A-to-D) converter. Substituted for the positive polarity constant current source circuit, is R202-R204, R211, or R212 (depending on the range selected), the +12V supply voltage, and transistor switch Q209.

Variations in the +12V voltage have no effect on accuracy, and the divider containing Rx which produces a non-linear V out vs Rx is ideally compensated for in the modified A-to-D converter.

Active Filter

An active filter is utilized to provide the major part of the NMR at the input to the A-to-D converter (See Figure 5-12). AC rolloff is 40dB per decade. The output voltage is taken from the AC summing node of the amplifier consisting of operational amplifier U204, C208, C209 and R together with the 100k input source resistance.

Power Supply

The battery charger and battery supply are shown in Figure 5-13. The step-down transformer and fuse provide current limiting resistance for charging. Diode CR121 provides half-wave rectification. The nominal +5V is used directly by the following:

1. LED display
2. AC converter operational amplifier
3. Logic

A DC-DC converter is used to generate +12 volts and -12 volts.

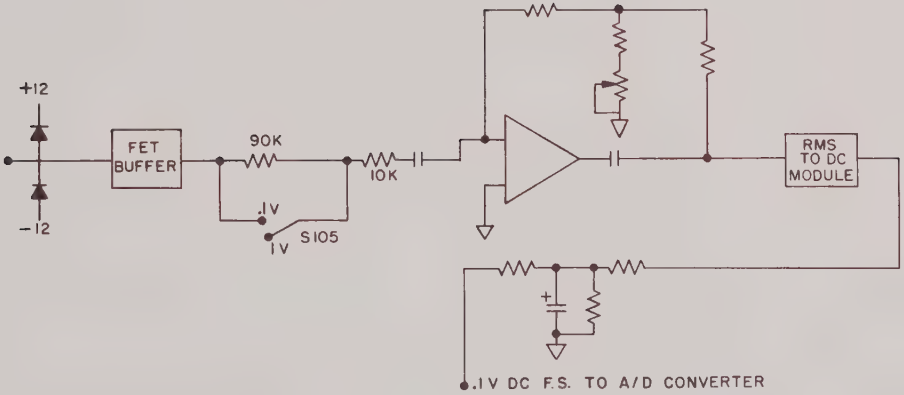

Figure 5-10. AC Converter Circuit

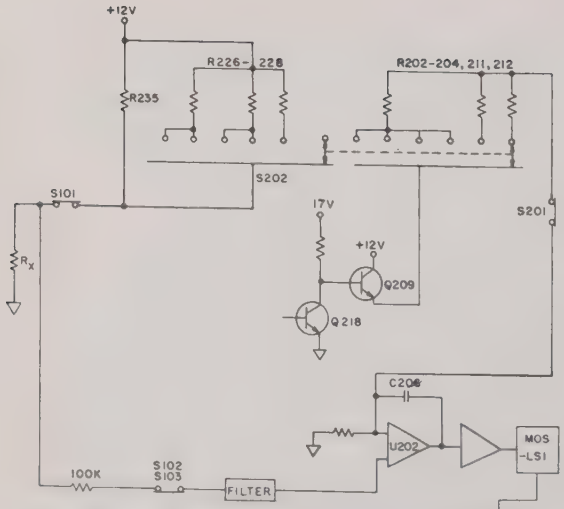

Figure 5-11. Ohms Measurement Circuit

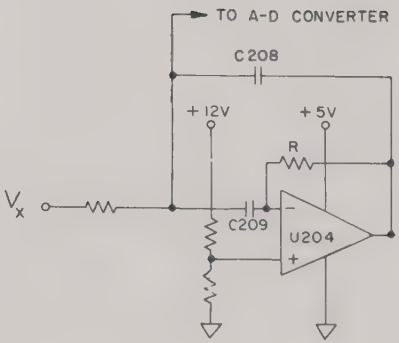

Figure 5-12. Active Filter Circuit

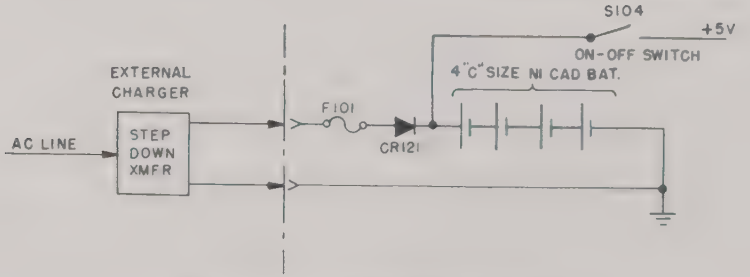

Figure 5-13. AC Line/Battery Operation

SECTION 6
MAINTENANCE

CALIBRATION

To calibrate the Model 4445, all adjustments are accessible without uncasing. The AC gain pot and AC zero pot are on the rear, with the balance of the adjustments accessible when the dial plate is removed.

The dial plate is removed by inserting the tip of a ball-point pen in the zero hole, and carefully prying up the plastic plate which snaps out. The adjustments are identified as shown in Figure 6-1, (numbers 1 through 8 inclusive).

BATTERY ACCESSIBILITY

Although nickel cadmium cells typically provide years of service, it is possible that battery operation

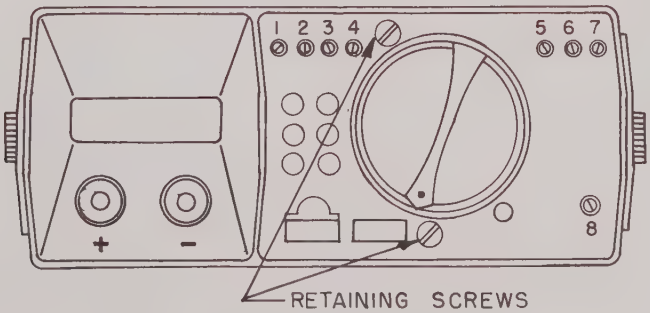

Figure 6-1. Calibration

PERFORMANCE CHECK (25°C)	CORRECTIVE ACTION
1. Charger circuit fuse: With line operation the battery voltage should stabilize above 5.0 volts with sustained usage.	Replace fuse F101 (See Figure 6-2).
2. Input fuse: Short the input on the 100mVDC range. Zero should appear.	Replace fuse F102 (See Fig. 4-2). Adjust zero. (R229 or adjustment No. 1 on front panel)
3. Reference adjustments: (a) Apply +190.0mVDC on 100mVDC range. (b) Apply -190.0mVDC on 100mVDC range.	Adjust R257 (adjustment No. 2 on front panel) until display reads correctly. Adjust R247 (adjustment No. 3 on front panel) until display reads correctly.
4. DC gain control: Apply 1.900 volts DC on the 1 volt range.	Adjust R233 (adjustment No. 4 on front panel) until display reads correctly.
5. 10 megohm: Apply a 10.00 resistor to the input.	Adjust R212 (adjustment No. 5) until display reads correctly.
6. 1 megohm: Apply a 1.900MΩ resistor to the input.	Adjust R211 (adjustment No. 6) until display reads correctly.
7. 10kΩ: Apply a 19.00kΩ resistor to the input.	Adjust R204 (adjustment No. 7 on front panel) for correct display.
8. AC zero: Short the input on 1VAC range. Zero should appear.	Adjust R148 (rear panel) for reading of 0.0, approaching from direction of positive readings and not going beyond zero.
9A. 100mV: Apply 190.0mV 400Hz	Adjust R146 (adjustment on rear of case) for correct display.
9B. 100mV: Apply 190.0mV 10kHz	Note reading.
10. 10V: Apply 19V 10kHz	Adjust C106 (adjustment No. 8) on front panel for same reading as in step 9B.
11. Ohms circuit stays at zero.	Replace input fuse F102.

will be required with insufficient time for adequate recharging. In this event either four zinc-carbon or four previously charged C size batteries can be used.

Protection is provided to prevent damage to circuitry if batteries are installed with incorrect polarity. A fuse will blow if the batteries are improperly installed when the charger is connected to both the DMM and the power line.

Either to reach the batteries or to replace the charger circuit fuse, the battery compartment must be removed. See Figure 6-2.

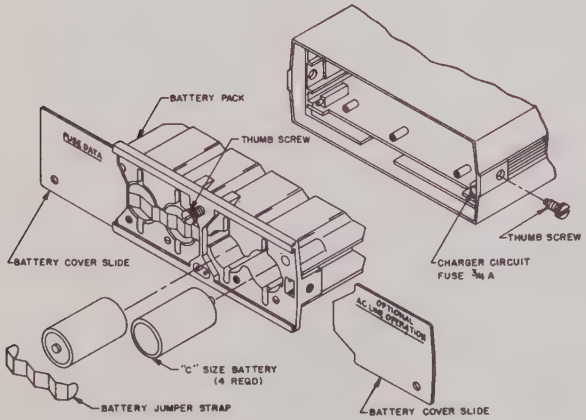

Figure 6-2. Battery Accessibility

Fuse access only:

1. Remove two thumb screws.
2. Screw one of the thumb screws on recessed stud grasping DMM case with one hand, gently ease out the battery compartment, using the inserted thumb screw as a grip.

Battery and spare fuse access:

3. Slide out the battery covers.
4. Slip out battery jumper straps.
5. Slide the cells from their compartments.

Reverse the above sequence for assembly.

Battery polarity markings are molded in to both ends of each cell compartment. Battery cover slides must be fully inserted to permit proper installation of the battery pack.

SECTION 7

DRAWINGS AND PARTS LIST

This section contains drawings, schematic diagrams and parts list for the instrument.

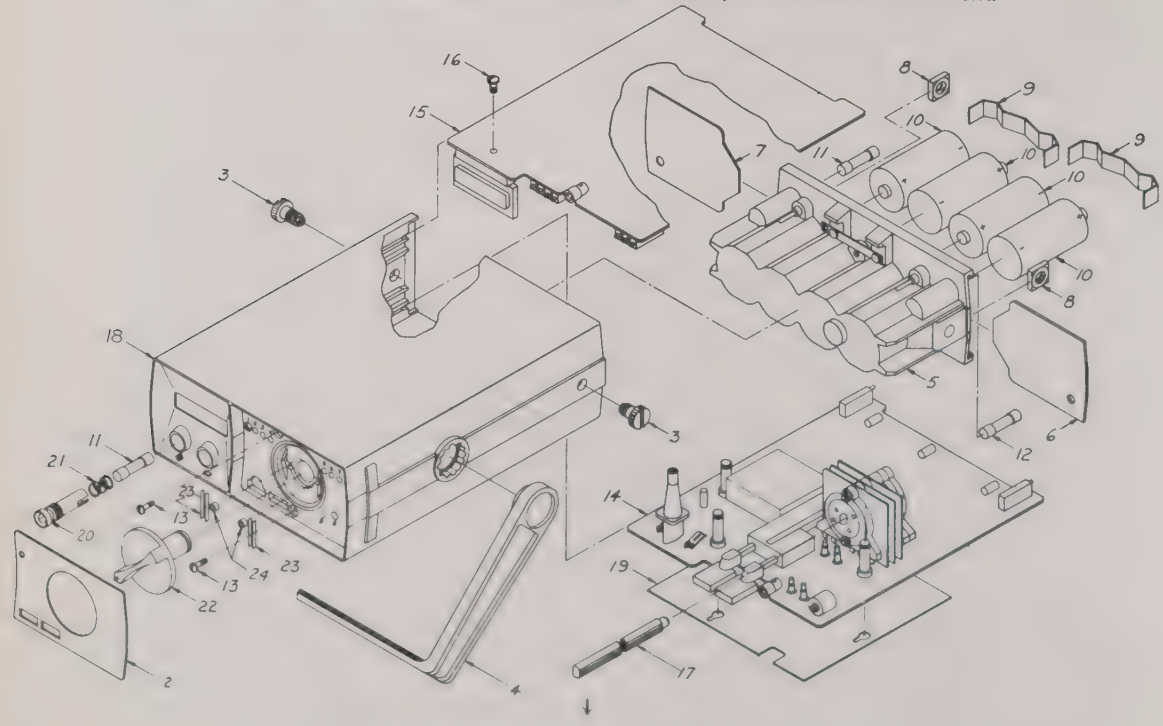

Figure 7-1. Assembly

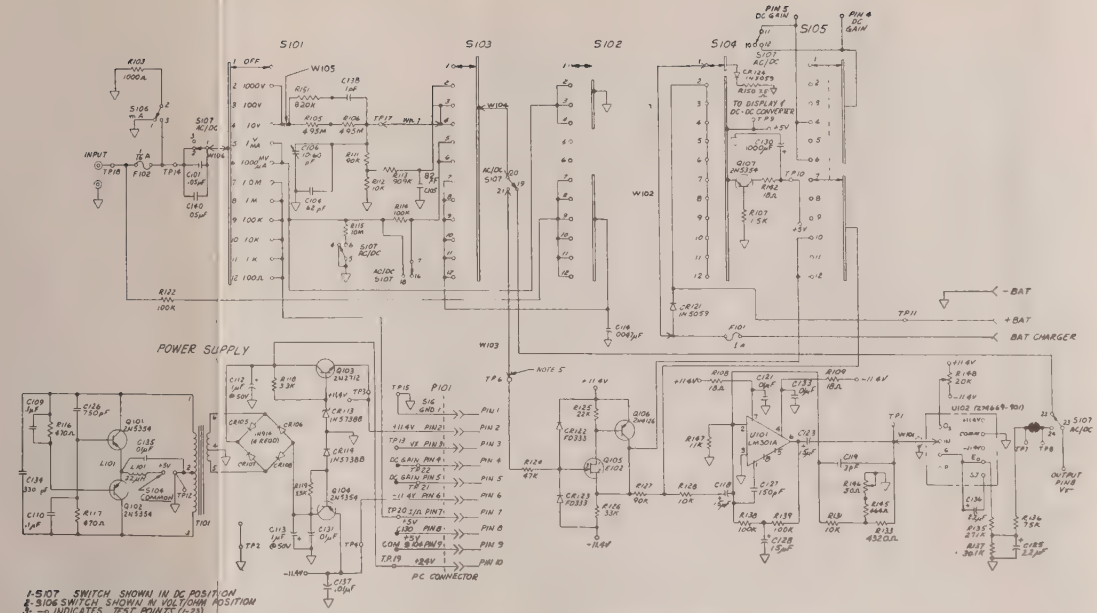

Figure 7-3. Schematic Diagram, Lower Board

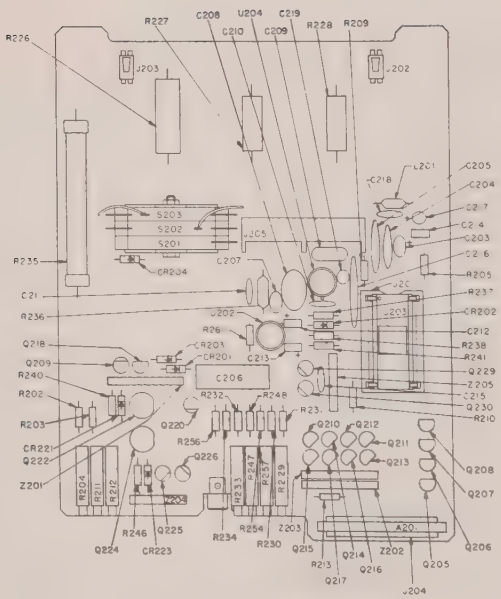

Figure 7-4. Upper Board Assembly

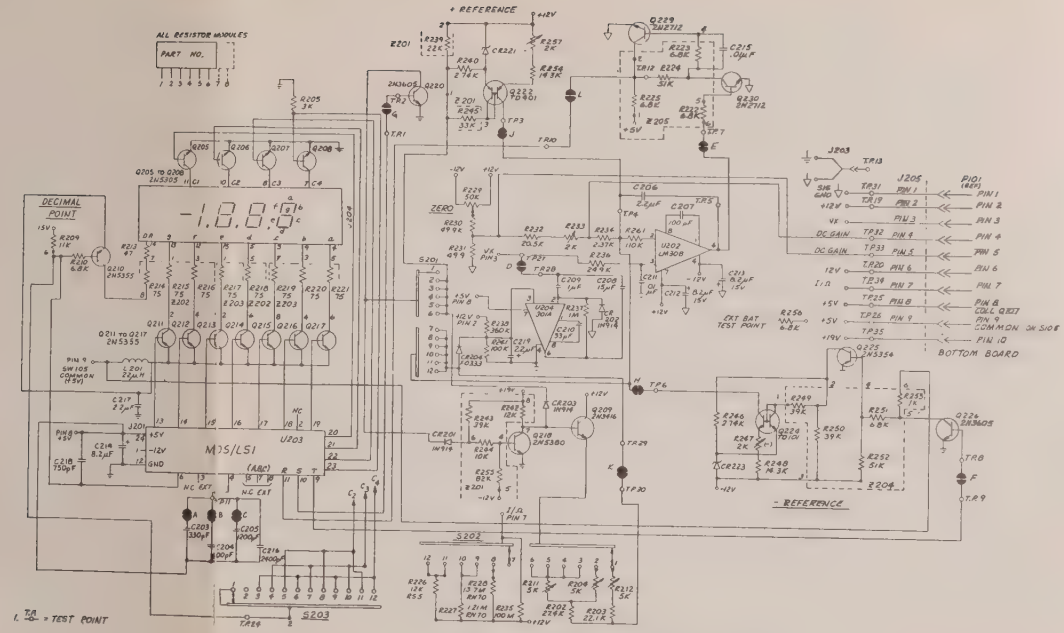

Figure 7-5. Schematic Diagram, Upper Board

PARTS LIST

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	ASSEMBLY (Ref Figure 7-1)	
1	DIGITAL MULTIMETER (117V)	274689
1	DIGITAL MULTIMETER (234V)	275256
2	DIAL, PRINTED (117V)	274686-901
2	DIAL, PRINTED (234V)	274686-902
3	SCREW, THUMB	272142-024
4	HANDLE	272121-001
5	CASE ASSY, BATTERY	272975-901
6	COVER, BATTERY	273039-905
7	COVER, BATTERY (117V)	273039-904
7	COVER, BATTERY (234V)	273039-906
8	NUT, BATTERY CASE MTG	272143-001
9	CONTACT, BATTERY SHORTING	272970-024
10	BATTERY, C SIZE, NiCad, 1.2V	274120-001
11	FUSE, 0.062 AMPS, 8AG	ND60763-001
12	FUSE, 1 AMP, 8AG	276265-001
13	SCREW, BOARD MTG	ND39831-024
14	BOARD ASSY, LOWER	274662-901
15	BOARD ASSY, DIGITAL, UPPER	274346-901
16	SCREW	ND40586-024
17	SHAFT, RANGE SWITCH	269436-001
18	CASE	272126-001
19	SHIELD, AC COVER, OUTSIDE	274365-024
20	SOCKET, FUSE	272134-024
21	SPRING	271054-024
22	KNOB	267331-901
23	SPRING, DETENT	267333-001
24	ROLLER, DETENT	267334-001
–	HARDWARE, PANEL MTG	187205-953
–	LEAD ASSY	270066-001
–	BATTERY CHARGER, 105-130V 50-400Hz	274893-901
–	BATTERY CHARGER, 210-260V 50-400Hz	275805-901

PARTS LIST

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	ASSEMBLY (Ref Figure 7-1)	
1	DIGITAL MULTIMETER (117V)	274689
1	DIGITAL MULTIMETER (234V)	275256
2	DIAL, PRINTED (117V)	274686-901
2	DIAL, PRINTED (234V)	274686-902
3	SCREW, THUMB	272142-024
4	HANDLE	272121-001
5	CASE ASSY, BATTERY	272975-901
6	COVER, BATTERY	273039-905
7	COVER, BATTERY (117V)	273039-904
7	COVER, BATTERY (234V)	273039-906
8	NUT, BATTERY CASE MTG	272143-001
9	CONTACT, BATTERY SHORTING	272970-024
10	BATTERY, C SIZE, NiCad, 1.2V	274120-001
11	FUSE, 0.062 AMPS, 8AG	ND60763-001
12	FUSE, 1 AMP, 8AG	276265-001
13	SCREW, BOARD MTG	ND39831-024
14	BOARD ASSY, LOWER	274662-901
15	BOARD ASSY, DIGITAL, UPPER	274346-901
16	SCREW	ND40586-024
17	SHAFT, RANGE SWITCH	269436-001
18	CASE	272126-001
19	SHIELD, AC COVER, OUTSIDE	274365-024
20	SOCKET, FUSE	272134-024
21	SPRING	271054-024
22	KNOB	267331-901
23	SPRING, DETENT	267333-001
24	ROLLER, DETENT	267334-001
–	HARDWARE, PANEL MTG	187205-953
–	LEAD ASSY	270066-001
–	BATTERY CHARGER, 105-130V 50-400Hz	274893-901
–	BATTERY CHARGER, 210-260V 50-400Hz	275805-901

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	LOWER BOARD ASSY (Ref Figures 7-2 & 7-3)	
C101	CAPACITOR, 0.05μF -20% + 80%, 600 WVDC	ND37567-001
C104	CAPACITOR, 62pF ±2%, 500 WVDC	274127-001
C105	CAPACITOR, 82pF ±5%, 300 WVDC	272262-001
C106	CAPACITOR, 10-60pF, 250 WVDC	270081-001
C109	CAPACITOR, 0.1μF -20% + 80%, 10 WVDC	272376-001
C110	CAPACITOR, 0.1μF -20% + 80%, 10 WVDC	272376-001
C112	CAPACITOR, 1μF ±20%, 50 WVDC	272897-001
C113	CAPACITOR, 1μF ±20%, 50 WVDC	272897-001
C114	CAPACITOR, 0.0047μF -20% + 50%, 125 WVDC	269898-001
C118	CAPACITOR, 15μF ±20%, 10 WVDC	269951-001
C119	CAPACITOR, 3pF ±1pF, 300 WVDC	269947-001
C121	CAPACITOR, 0.01μF ±20%, 50 WVDC	276310-001
C123	CAPACITOR, 15μF ±20%, 10 WVDC	269951-001
C125	CAPACITOR, 2.2μF ±20%, 15 WVDC	274118-001
C126	CAPACITOR, 750pF ±10%, 1000 WVDC	274154-001
C127	CAPACITOR, 150pF ±10%, 1000 WVDC	274101-001
C128	CAPACITOR, 15μF ±20%, 10 WVDC	269951-001
C130	CAPACITOR, 1000μF -10%, +50%, 10 WVDC	275631-001
C131	CAPACITOR, 0.01μF ±20%, 50 WVDC	276310-001
C133	CAPACITOR, 0.01μF ±20%, 100 WVDC	ND37639-001
C134	CAPACITOR, 330pf ±10%, 1000 WVDC	270044-001
C135	CAPACITOR, 0.01μF ±20%, 100 WVDC	ND37639-001
C136	CAPACITOR, 2.2μF ±20%, 15 WVDC	274118-001
C137	CAPACITOR, 0.01μF ±20%, 100 WVDC	ND37639-001
C138	CAPACITOR, 1pf ±.1pF, 1500 WVDC	276264-001
C140	CAPACITOR, 0.05μF -20% + 80%, 600 WVDC	ND37567-001
CR105	DIODE, 1N914	ND61025-001
CR106	DIODE, 1N914	ND61025-001

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	LOWER BOARD ASSY (Ref Figures 7-2 & 7-3) (continued)	
CR107	DIODE, 1N914	ND61025-001
CR108	DIODE, 1N914	ND61025-001
CR113	DIODE, 1N5738B	275542-001
CR114	DIODE, 1N5738B	275542-001
CR121	DIODE, 1N5059	266611-001
CR122	DIODE, FD333	269922-001
CR123	DIODE, FD333	269922-001
CR124	DIODE, 1N5059	266611-001
F101	FUSE, 1 AMP 8AG	276265-001
L101	CHOKE, 22μH $\pm$10%	274145-001
P101	PLUG, INTERCONNECTION	272977-001
Q101	TRANSISTOR, 2N5354	268795-001
Q102	TRANSISTOR, 2N5354	268795-001
Q103	TRANSISTOR, 2N2712	ND39917-001
Q104	TRANSISTOR, 2N5354	268795-001
Q105	TRANSISTOR, E102	269958-001
Q106	TRANSISTOR, 2N4126	269956-001
Q107	TRANSISTOR, 2N5354	268795-001
R103	RESISTOR, 1000 ohms $\pm$.1%, 1/4 watt	272895-001
R105	RESISTOR, 4.95M ohms	
R106	RESISTOR, 4.95M ohms	Matched Set 275548-001
R111	RESISTOR, 90K ohms	
R112	RESISTOR, 10K ohms	

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	LOWER BOARD ASSY (Ref Figures 7-2 & 7-3) (continued)	
R107	RESISTOR, 1.5K ohms ±5%, 1/4 watt	275561-001
R108	RESISTOR, 18 ohms ±5%, 1/4 watt	275565-001
R109	RESISTOR, 18 ohms ±5%, 1/4 watt	275565-001
R113	RESISTOR, 90.9K ohms ±1%	272210-001
R114	RESISTOR, 100K ohms ±1%	266313-001
R115	RESISTOR, 10M ohms ±5%, 1/4 watt	274158-001
R116	RESISTOR, 470 ohms ±5%, 1/4 watt	274196-001
R117	RESISTOR, 470 ohms ±5%, 1/4 watt	274196-001
R118	RESISTOR, 3.3K ohms ±5%, 1/4 watt	269890-001
R119	RESISTOR, 3.3K ohms ±5%, 1/4 watt	269890-001
R122	RESISTOR, 100K ohms ±1%	266446-001
R124	RESISTOR, 47K ohms ±5%, 1/2 watt	ND20594-001
R125	RESISTOR, 22K ohms ±5%, 1/4 watt	275563-001
R126	RESISTOR, 33K ohms ±5%, 1/4 watt	269869-001
R127	RESISTOR, 90K ohms } Matched Set	272853-001
R128	RESISTOR, 10K ohms }	
R131	RESISTOR, 10K ohms ±1%, 1/10 watt	266627-001
R133	RESISTOR, 4.32K ohms ±1%, 1/10 watt	272334-001
R135	RESISTOR, 271K ohms ±1%, 1/10 watt	275643-001
R136	RESISTOR, 75K ohms ±1%, 1/10 watt	272211-001
R137	RESISTOR, 30.1K ohms ±1%, 1/10 watt	269931-001
R138	RESISTOR, 100K ohms ±5%, 1/4 watt	266592-001
R139	RESISTOR, 100K ohms ±5%, 1/4 watt	266592-001
R142	RESISTOR, 18 ohms ±5%, 1/4 watt	275565-001
R145	RESISTOR, 464 ohms ±1%, 1/10 watt	266634-001
R146	RESISTOR, VARIABLE, 50 ohms ±10%	272894-001
R147	RESISTOR, 11K ohms ±5%, 1/4 watt	275564-001
R148	RESISTOR, VARIABLE, 20K ohms	270161-001

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	LOWER BOARD ASSY (Ref Figures 7-2 & 7-3) (continued)	
R150	RESISTOR, 7.5 ohms ±5%, 2-1/4 watts	276266-001
R151	RESISTOR, 820K ohms ±5%, 1/2 watt	266420-001
S101 thru S105	SWITCH ASSY, RANGE	274781-901
S106 & S107	SWITCH ASSY, PUSH BUTTON	276267-001
T101	TRANSFORMER	274681-901
U101	AMPLIFER, LM301A	272691-001
U102	MODULE, RMS TO DC CONVERTER	274669-901
W101	LEAD, HOOK UP	274927-901
W102	LEAD, HOOK UP	246374-979
W103	LEAD, HOOK UP	246374-943
W104	LEAD, HOOK UP	275218-904
W105	LEAD, HOOK UP	265551-901
W106	LEAD, HOOK UP	275218-903
—	BOARD ASSY, HARDWARE	274662-902
—	BUTTON, PUSH	272124-001

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	UPPER BOARD ASSY (Ref Figures 7-4 & 7-5)	
A201	DISPLAY ASSY, L.E.D.	272114-902
C203	CAPACITOR, 330pF, ±10%, 1000WVDC	270044-001
C204	CAPACITOR, 600pF, ±10%, 500 WVDC	274133-001
C205	CAPACITOR, 1200pF, ±10%, 500WVDC	274132-001
C206	CAPACITOR, 2.2μF, ±10%, 50WVDC	275522-001
C207	CAPACITOR, 68pF, ±10%, 1000WVDC	272422-001
C208	CAPACITOR, .15μF, ±10%, 250WVDC	275547-001
C209	CAPACITOR, .1μF, ±10%, 250WVDC	275610-001
C210	CAPACITOR, 33pF, ±10%, 500 WVDC	275553-001
C211	CAPACITOR, .01μF, ±20%, 100WVDC	ND37639-001
C212	CAPACITOR, 8.2μF, ±20%, 15WVDC	269952-001
C213	CAPACITOR, 8.2μF, ±20%, 15WVDC	269952-001
C214	CAPACITOR, 8.2μF, ±20%, 15WVDC	269952-001
C215	CAPACITOR, .01μF, ±20%, 100WVDC	ND37639-001
C216	CAPACITOR, 2400pF, ±10%, 200WVDC	275595-001
C217	CAPACITOR, 2.2μF, ±20%, 15WVDC	274118-001
C218	CAPACITOR, 750pF, ±10%, 1000WVDC	274154-001
C219	CAPACITOR, 2.2μF, ±20%, 15WVDC	274118-001
CR201	DIODE, 1N914	ND61025-001
CR202	DIODE, 1N914	ND61025-001
CR203	DIODE, 1N914	ND61025-001
CR204	DIODE, FD333	269922-001
CR221	DIODE, ZENER, 1N4577	275524-001
CR223	DIODE, ZENER, 1N4577	275524-001
J201	SOCKET, RECEPTACLE LSI	274296-001
J202 & J203	SOCKET, Molex 1850A3	269945-001

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	UPPER BOARD ASSY (Ref Figures 7-4 & 7-5) (continued)	
J204	DISPLAY, RECEPTACLE	272847-001
J205	CONNECTOR	274121-001
L201	CHOKE, 22μH, $\pm$10%	274145-001
Q205	TRANSISTOR, 2N5305	275559-001
Q206	TRANSISTOR, 2N5305	275559-001
Q207	TRANSISTOR, 2N5305	275559-001
Q208	TRANSISTOR, 2N5305	275559-001
Q209	TRANSISTOR, 2N3416	263642-001
Q210	TRANSISTOR	272893-001
Q211	TRANSISTOR	272893-001
Q212	TRANSISTOR	272893-001
Q213	TRANSISTOR	272893-001
Q214	TRANSISTOR	272893-001
Q215	TRANSISTOR	272893-001
Q216	TRANSISTOR	272893-001
Q217	TRANSISTOR	272893-001
Q218	TRANSISTOR, 2N5380	275539-001
Q220	TRANSISTOR, 2N3605	268796-001
Q222	TRANSISTOR, TD401A	269904-001
Q224	TRANSISTOR, TD101A	266399-001
Q225	TRANSISTOR, 2N5354	268795-001
Q226	TRANSISTOR, 2N3605	268796-001
Q229	TRANSISTOR, 2N2712	ND39917-001
Q230	TRANSISTOR, 2N2712	ND39917-001
R202	RESISTOR, 27.4K ohms $\pm$1%, 1/10 watt	266633-001
R203	RESISTOR, 22.1K ohms $\pm$1%, 1/10 watt	264685-001
R204	RESISTOR, VARIABLE, 5K ohms $\pm$10%	269919-001
R205	RESISTOR, 3K ohms $\pm$5%, 1/4 watt	269857-001

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	UPPER BOARD ASSY (Ref Figures 7-4 & 7-5) (continued)	
R209	RESISTOR, 11K ohms ±5%, 1/4 watt	275564-001
R210	RESISTOR, 6.8K ohms ±5%, 1/4 watt	275566-001
R211	RESISTOR, VARIABLE 5K ohms ±10%	269919-001
R212	RESISTOR, VARIABLE, 5K ohms ±10%	269919-001
R213	RESISTOR, 47 ohms ±5%, 1/4 watt	272716-001
R226	RESISTOR, 12K ohms } Matched	
R227	RESISTOR, 1.21M ohms } Set	275552-001
R228	RESISTOR, 13.7M ohms ±1%	275551-001
R229	RESISTOR, VARIABLE, 50K ohms ±10%	272858-001
R230	RESISTOR, 49.9K ohms ±1%, 1/8 watt	269884-001
R231	RESISTOR, 49.9 ohms ±1%, 1/8 watt	269886-001
R232	RESISTOR, 20.5K ohms ±1%, 1/8 watt	275543-001
R233	RESISTOR, VARIABLE, 2K ohms ±10%	272869-001
R234	RESISTOR, 2.37K ohms ±1%, 1/8 watt	275544-001
R235	RESISTOR, 100M ohms ±1%	275554-001
R236	RESISTOR, 24.9K ohms ±1%, 1/8 watt	272868-001
R237	RESISTOR, 1M ohms ±5%, 1/4 watt	268782-001
R238	RESISTOR, 360K ohms ±5%, 1/4 watt	270085-001
R240	RESISTOR, 2.74K ohms ±1%, 1/10 watt	272863-001
R241	RESISTOR, 100K ohms ±5%, 1/4 watt	266592-001
R246	RESISTOR, 2.74K ohms ±1%, 1/10 watt	272863-001
R247	RESISTOR, VARIABLE, 2K ohms ±10%	272869-001
R248	RESISTOR, 14.3K ohms ±1%, 1/10 watt	269927-001
R254	RESISTOR, 14.3K ohms, ±1%. 1/10 watt	269927-001
R256	RESISTOR, 6.8K ohms ±5%, 1/4 watt	275566-001
R257	RESISTOR, VARIABLE, 2K ohms ±10%	272869-001
R261	RESISTOR, 110K ohms ±1%, 1/10 watt	270199-001

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	UPPER BOARD ASSY (Ref Figures 7-4 & 7-5) (continued)	
S201 thru S203	SWITCH ASSY, RANGE	274359-001
U202	AMPLIFIER, LM308	271819-001
U203	INTEGRATED CIRCUIT, MOS SLI	272612-001
U204	AMPLIFIER, 301A	272691-001
Z201	RESISTOR, MODULE, + REF/OHMS	274347-001
Z202	RESISTOR, MODULE, 75 ohms	274364-001
Z203	RESISTOR, MODULE, 75 ohms	274364-001
Z204	RESISTOR, MODULE, - REF	272159-001
Z205	RESISTOR, MODULE, COMPARATOR	273881-001
–	BOARD ASSY, HARDWARE	274346-902

WESTON EQUIPMENT WARRANTY

Weston warrants equipment of its manufacture against defective materials or workmanship for a period of one year from date of shipment.

The liability of Seller under this warranty is limited, at Seller's option, solely to repair, replacement with equivalent Weston equipment, at an appropriate credit adjustment not to exceed the original equipment sales price, of equipment returned to the Seller provided that (a) Seller is promptly notified in writing by Buyer upon discovery of defects, (b) Upon receipt of written authorization from Seller the defective equipment is returned as directed, transportation charges prepaid by Buyer, and (c) Seller's examination of such equipment discloses to his satisfaction that defects were not caused by negligence, misuse, improper installation, accident, or unauthorized repair or alteration by the Buyer.

This warranty does not include mechanical parts failing from normal usage nor does it cover limited life electrical components which deteriorate with age such as tubes, lamps, etc.

This warranty is in lieu of all other warranties, expressed or implied, including the implied warranty of fitness for a particular purpose to the original purchaser or to any other person. Seller shall not be liable for consequential damages of any kind.

The aforementioned provisions do not extend the original warranty period of any article which has been either repaired or replaced by Seller.

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